Power Mac G5

Technology Overview
October 2005

Contents

Page 3 **The Power of Four**
Inside the Power Mac G5
Outside the Power Mac G5

Page 6 **Quad-Core Processing**
Two Dual-Core PowerPC G5 Processors
Bidirectional Frontside Bus
64-Bit Processor Architecture
Eight Double-Precision Floating-Point Units
Four Velocity Engine Units
Multiple Cores and Mac OS X

Page 10 **PCI Express Architecture**
533MHz DDR2 Main Memory
PCI Express Graphics
PCI Express Expansion
Dual Gigabit Ethernet
High-Performance I/O

Page 15 **Workstation Graphics**
Advanced Graphics Options
Apple Cinema Displays
Support for Multiple Displays

Page 20 **Real-World Advantages**
Film and Video
Science and Technical Computing
Design and Print
Music and Audio

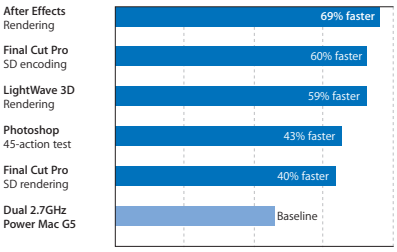
Page 29 **Configurations and Options**

Page 31 **Technical Specifications**

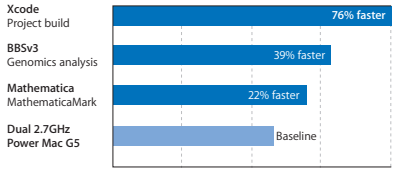
The Power of Four

The new Power Mac G5 Quad delivers groundbreaking performance compared with the fastest previous Power Mac.[1]

Creative application performance



Technical computing performance



Power. It gives your creativity room to play. It takes the edge off supersized projects and looming deadlines. It challenges you to seek more demanding work and gives you the confidence to execute with brilliance.

Introducing the Power Mac G5 Quad. Now you can blaze through your work, deliver ahead of schedule, wow your clients, even transform your business—because this quad-core system really moves. It runs creative applications up to 69 percent faster than the fastest previous Power Mac, the 2.7GHz dual-processor Power Mac G5.[1]

Quad-core processing
With two dual-core processors, the Power Mac G5 Quad doubles the computational power of its dual-processor predecessor. Do the math: Quad-core processing means four 64-bit PowerPC G5 processor cores, four Velocity Engine units, and eight double-precision floating-point units for blistering performance of up to 76.6 gigaflops. That means you can manipulate mountains of images or miles of footage. Crunch enormous data sets. Encode HD video or audiophile-quality music. All at speeds you never imagined possible.

PCI Express architecture
An all-new PCI Express architecture opens up a world of high-performance peripherals to the Mac platform. This modern industry standard allows you to customize your Power Mac G5 to the special needs of your workflow—providing tremendous power and productivity in a single system. As your needs change, you'll have the flexibility to add emerging solutions for networked storage, digital signal processing (DSP), video management, data acquisition, and more.

Workstation graphics
Graphics assume a new level of realism with the latest PCI Express graphics cards. The optional NVIDIA Quadro FX 4500—the first workstation graphics processing unit (GPU) for the Mac—accelerates 3D content creation, special effects, animation, and scientific visualizations. How much reality can you handle? Try adding up to eight all-digital Apple Cinema HD Displays to your Power Mac G5 and enjoy a veritable dreamscape. You can even experience full-screen stereo 3D for immersive game play or stereo-in-a-window for scientific workflows.

Quad-core processing, PCI Express architecture, and workstation graphics are only the beginning. Find out how the new Power Mac G5 can streamline your work, unlock opportunities, and deliver results that exceed your grandest expectations.

Inside the Power Mac G5

The Power Mac G5 is loaded with state-of-the-art technologies that translate into blistering performance. Take a tour of this power-packed interior.

SuperDrive with double-layer support
The SuperDrive built into every Power Mac G5 reads and writes a wide variety of DVD and CD media. You can even author media or archive data on double-layer (DVD+R DL) discs capable of holding up to 8.5GB of data.

Serial ATA storage
Two Serial ATA hard drive bays with a 1.5-Gbps interface provide up to 1TB of fast internal storage[2]—ideal for video, audio, and high-resolution graphics. Software RAID in Mac OS X allows you to stripe the drives for increased performance or mirror them for high reliability.

PCI Express expansion
Three PCI Express expansion slots with four or eight lanes allow you to add PCI Express cards for video capture and playback, audio DSP, and other special tasks. For massive storage, just add an Apple Fibre Channel PCI Express Card and Xserve RAID, Apple's high-performance storage system.

Up to 16GB of main memory
Eight DIMM slots hold up to 16GB of fast new 533MHz DDR2 SDRAM. For mission-critical and compute-intensive environments, you now have the option of ECC (Error Correction Code) memory for automatic correction and detection of data errors.

Dual-core PowerPC G5 processor
Two independent cores on one processor, each with 1MB of L2 cache and running at clock speeds up to 2.5GHz—it all adds up to awesome power in your choice of configurations, including the groundbreaking quad-core Power Mac G5 Quad, which runs key applications up to 69 percent faster than the fastest dual-processor Power Mac G5.[1]

PCI Express graphics
The 16-lane PCI Express slot holds your choice of the latest consumer and workstation graphics cards. The new standard for high-performance graphics, PCI Express delivers throughput of up to 4 GBps—twice that of its AGP 8X predecessor—for ultrafast 3D, glorious onscreen details, and immersive visualization.

Outside the Power Mac G5

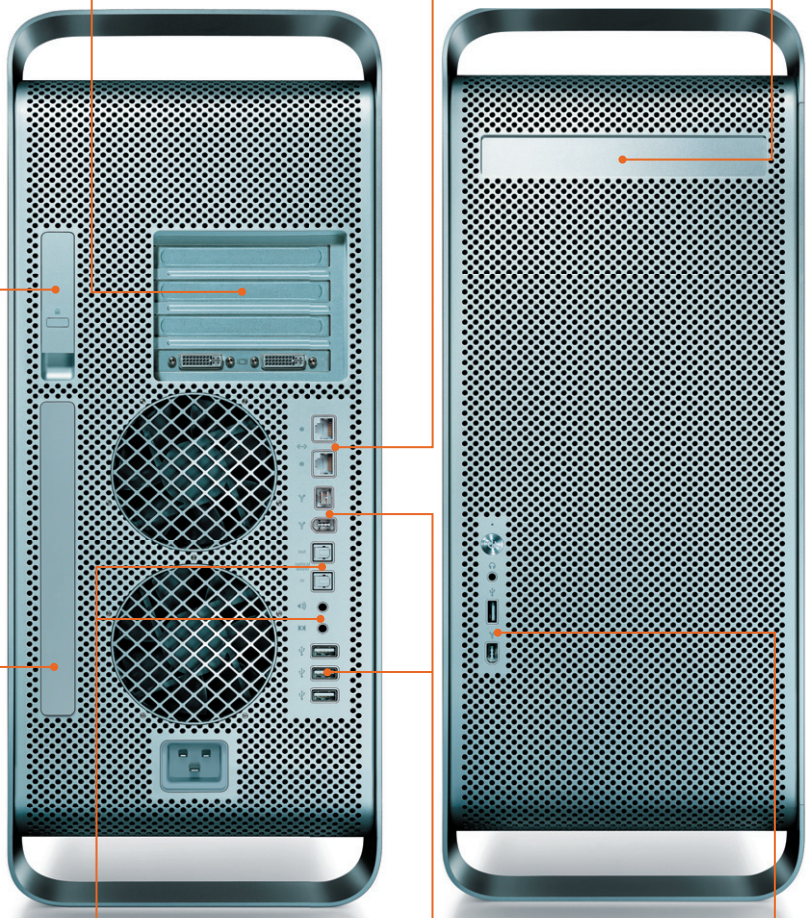
Handsome good looks combine with a user-centered design that includes convenient ports and an easy-to-open (and easy-to-lock) side panel. All configurations of the new Power Mac G5 come with a comprehensive suite of integrated innovations.

Easy-open side door
A removable side panel provides quick access to slots and bays, so you can install additional memory, a second hard drive, or a PCI Express card. To secure internal components, simply add a lock to the panel latch.

PCI Express slots
Connect your choice of 16-lane PCI Express graphics cards to one or two displays, and install up to three PCI Express expansion cards to add cutting-edge devices to your Power Mac G5 system.

Dual Gigabit Ethernet ports
Two Gigabit (10/100/1000BASE-T) Ethernet interfaces allow you to connect the Power Mac G5 to both a public and a private network—ideal, for example, for simultaneous access to the Internet and an Xsan network. Dual Gigabit Ethernet also enables server-class features such as support for VLAN tags, jumbo frames, and port aggregation.

SuperDrive
Read and write to most types of CD and DVD media using the built-in 16x SuperDrive with double-layer support.



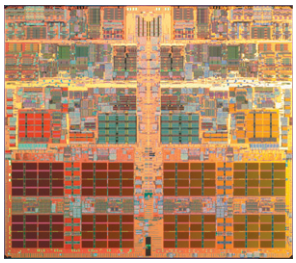
Antenna for wireless connections
A built-in antenna and optional AirPort Extreme[3] and Bluetooth technologies make wireless networking easy. Create or join AirPort wireless networks, exchange files wirelessly with another AirPort-equipped Mac, or connect to Bluetooth-enabled mobile phones, PDAs, and printers—and to Apple's wireless keyboard and mouse.

Analog and optical digital audio
Optical digital audio ports support stereo and 5.1 surround sound speaker systems, while analog stereo audio line-level input and output ports allow you to connect analog audio decks and devices.

FireWire and USB 2.0 ports
Plug in your choice of peripherals and devices. Each system has one FireWire 400 port on the front, one FireWire 400 port on the back, a FireWire 800 port on the back, and four USB 2.0 ports—one on the front and three on the back. There are also two USB 1.1 ports on the keyboard.

Convenient front I/O ports
The front panel of the Power Mac G5 features an integrated speaker, headphone minijack, FireWire port, USB 2.0 port, and power button.

Quad-Core Processing



With two independent cores on one processor, the new PowerPC G5 packs tremendous processing power on a single chip.

Enter the dual-core PowerPC G5 processor: one silicon chip with two independent processor cores. Now take two of those dual-core chips and you have the Power Mac G5 Quad, for groundbreaking quad-core processing.

Quad-core processing means more 64-bit resources: more L2 cache, more Velocity Engine units, and more double-precision floating-point units. Videographers can edit more footage, filmmakers can produce more real-time effects, designers and photographers can process more higher-resolution images, and researchers can crunch through data sets for faster results. Compare a quad-core Power Mac G5 to the fastest dual-processor G5 ever built, and you'll experience up to 69 percent faster performance running popular professional applications.[1]

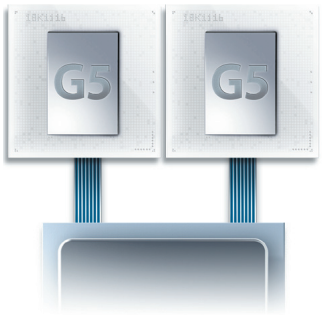
Two Dual-Core PowerPC G5 Processors

The new PowerPC G5 combines two processor cores on a single silicon chip, providing double the computational power in the same space as a single-core processor. What's more, each core has its own 1MB of L2 cache memory—double the size of its predecessor—so you'll have ultrafast access to twice the amount of frequently used data.

With two dual-core PowerPC G5 processors, the Power Mac G5 Quad doubles the ante. Applications can take advantage of four 64-bit processor cores, including four 1MB L2 caches, four 128-bit Velocity Engine units, and eight double-precision floating-point units, for a radical increase in desktop performance.

Comparison of PowerPC G4, single-core PowerPC G5, and dual-core PowerPC G5 processors

	PowerPC G4	Single-core PowerPC G5	Dual-core PowerPC G5
Architecture	32-bit	64-bit	64-bit
Addressable memory	4 gigabytes	4 terabytes	4 terabytes
Frontside bus	Single	Dual	Dual
Processor cores	One	One	Two
Velocity Engine units	One	One	Two
Floating-point units	One	Two	Four
Integer units	One	Two	Four
L1 data cache	32K	32K	Two sets of 32K
L1 instruction cache	32K	64K	Two sets of 64K
L2 cache	256K	512K	Two sets of 1MB



In Power Mac G5 Quad systems, each dual-core PowerPC G5 processor has its own bidirectional frontside bus.

Bidirectional Frontside Bus

Leveraging the dual frontside bus architecture pioneered in the original Power Mac G5, each dual-core processor has an independent data path to the system controller running at up to 1.25GHz. Unlike conventional processor interfaces, which carry data in only one direction at a time, this dual-channel frontside bus has two 32-bit point-to-point links (64 bits total): One link travels into the processor and another travels from the processor, which means no wait time while the processor and the system controller negotiate which will use the bus or while the bus switches direction. This enables data to move in opposite directions simultaneously—a dramatic improvement over previous processor interfaces.

In Power Mac G5 Quad systems, each processor has its own bidirectional interface to the system controller, unlike traditional dual-processor systems, which constrain throughput by placing all processor resources on one bus. Each G5 processor has a dedicated interface to main memory for total bandwidth of up to 10 GBps per processor, or a total of 20 GBps for a quad system. This high-performance frontside bus architecture also enables each core to discover and access data in the other cores' caches—further increasing performance on quad-core systems.

64-Bit Processor Architecture

The dual-core PowerPC G5 joins forces with Mac OS X v10.4 Tiger to enable 64-bit computation, including the ability to address vast amounts of main memory and to perform double-precision floating-point calculations.

Support for massive amounts of memory
The move to 64-bit processors results in a dramatic leap in the amount of memory supported. In practice, memory addressing is defined by the physical address space of the processor. The PowerPC G5, with 42 bits of physical address space, supports a colossal 2^{42} bytes, or 4 terabytes (4TB), of system memory. Although it's not currently feasible to purchase 4TB of RAM, the advanced architecture of this processor allows for plenty of growth in the future.

More practical and still far more than a typical PC, the Power Mac G5 can be configured with 16GB of addressable memory. Such large quantities of memory enable the system to contain a complex 3D model, massive digital images, a scientific simulation, or a sequence of video entirely in RAM. When data is stored in memory, the processor can access it 40 times faster than from the hard drive, drastically reducing the time to manipulate, modify, and render the data and making it feasible to tackle gigantic projects on a desktop system.

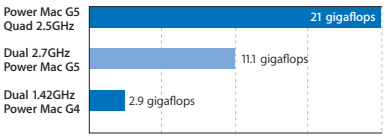
64-bit computation power
The other advantage provided by the 64-bit PowerPC G5 is the ability to perform multiple simultaneous 64-bit floating-point and integer calculations. The PowerPC G5 features full 64-bit data paths and data registers, allowing it to express the extreme precision needed for floating-point mathematics and to express integers up to 18 billion billion. By contrast, a 32-bit processor must break these types of computations into multiple pieces—requiring multiple passes through the processor and slowing down application performance.

Eight Double-Precision Floating-Point Units

The PowerPC G5 core contains two double-precision floating-point units, each capable of performing a multiply and an add at the same time. This means a Power Mac G5 Quad, with four processor cores and a total of eight floating-point units, can complete up to sixteen 64-bit floating-point operations in a single cycle.

Such immense 64-bit computational power accelerates applications in many fields, including audio creation, 3D content creation, and scientific visualization and analysis—resulting in performance levels far beyond those of previous Power Mac generations.

Linpack
A measure of a computer's floating-point execution performance, the Linpack benchmark solves a dense system of linear equations. The Power Mac G5 Quad executed the double-precision equations 88 percent faster than the dual 2.7GHz Power Mac G5 and an amazing 626 percent faster than the dual 1.42GHz Power Mac G4.



Fused multiply-add example
The floating-point units in the PowerPC G5 can complete both a multiply and an add operation as part of the same machine instruction—accelerating matrix multiplication, vector dot products, and other scientific computations. Referred to as fused multiply-add, or "fmadd," this instruction is considered a building block for data-intensive floating-point computation.

The following computation can be completed by a fused multiply-add instruction in one pass through either of the two floating-point units in a PowerPC G5 core:

$$T = (a * b) + c$$

On other processors, two instructions are required. The first is a multiply instruction:

$$U = (a * b)$$

The product "U" is used by a second instruction, an addition, to complete the computation:

$$V = U + c$$

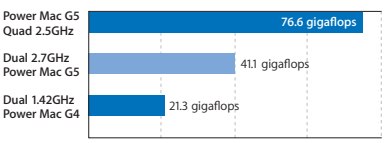
In processors with comparable clock speeds, the computation of "(a * b) + c" is completed twice as fast using fused multiply-add. It also delivers a more accurate result, because round-off occurs just once in the computation of "T"—while on other processors, round-off occurs twice: in the computation of "U" and in the computation of "V."

Four Velocity Engine Units

A dual-pipelined Velocity Engine in each processor core is optimized with two independent queues and dedicated 128-bit registers and data paths for efficient instruction and data flow. This 128-bit vector processing unit accelerates data manipulation by applying a single instruction to multiple data at the same time, known as SIMD processing. Originally implemented in the PowerPC G4, the Velocity Engine in the PowerPC G5 uses the same set of 162 instructions, enabling it to accelerate existing Mac OS X applications that have been optimized for the Velocity Engine.

Vector processing is useful for transforming large sets of data, such as manipulating an image or rendering a video effect. For example, when a designer uses a filter to apply a motion blur to an image, each pixel of the image must be changed according to the same set of instructions—a highly repetitive processing task. Each Velocity Engine pipeline speeds up this task by processing up to 128 bits of data, in four 32-bit integers, eight 16-bit integers, sixteen 8-bit integers, or four 32-bit single-precision floating-point values, in a single clock cycle. That works out to 16 simultaneous 32-bit floating-point operations on a Power Mac G5 Quad.

Gigaflops
The gigaflops test indicates a system's vector processing capability by measuring the maximum number of floating-point operations it can perform. With four Velocity Engine units, the Power Mac G5 Quad completed the test 85 percent faster than the dual 2.7GHz Power Mac G5 and 260 percent faster than the dual 1.42GHz Power Mac G4.



The Power Mac G5 comes with Mac OS X v10.4 Tiger, Apple's UNIX-based operating system, including powerful new features such as Spotlight, Dashboard, and Automator.

Multiple Cores and Mac OS X

Mac OS X is ideally suited to leverage the power of quad-core systems, since it was designed from day one for multiple processors. With symmetric multiprocessing, preemptive multitasking, and multithreading capabilities in Mac OS X, a Power Mac G5 Quad delivers groundbreaking performance.

Symmetric multiprocessing (SMP) in Mac OS X dynamically manages tasks across multiple processors—and multiple processor cores—without requiring any special optimization of the application or any special action on the user's part. With SMP, you can run a processor-intensive task in the background while you work with another application. Mac OS X assigns each of these tasks to a different processor or core, allowing the tasks to execute simultaneously, and automatically balances the load between processors. Preemptive multitasking further optimizes performance by allowing Mac OS X to prioritize tasks on each processor or core.

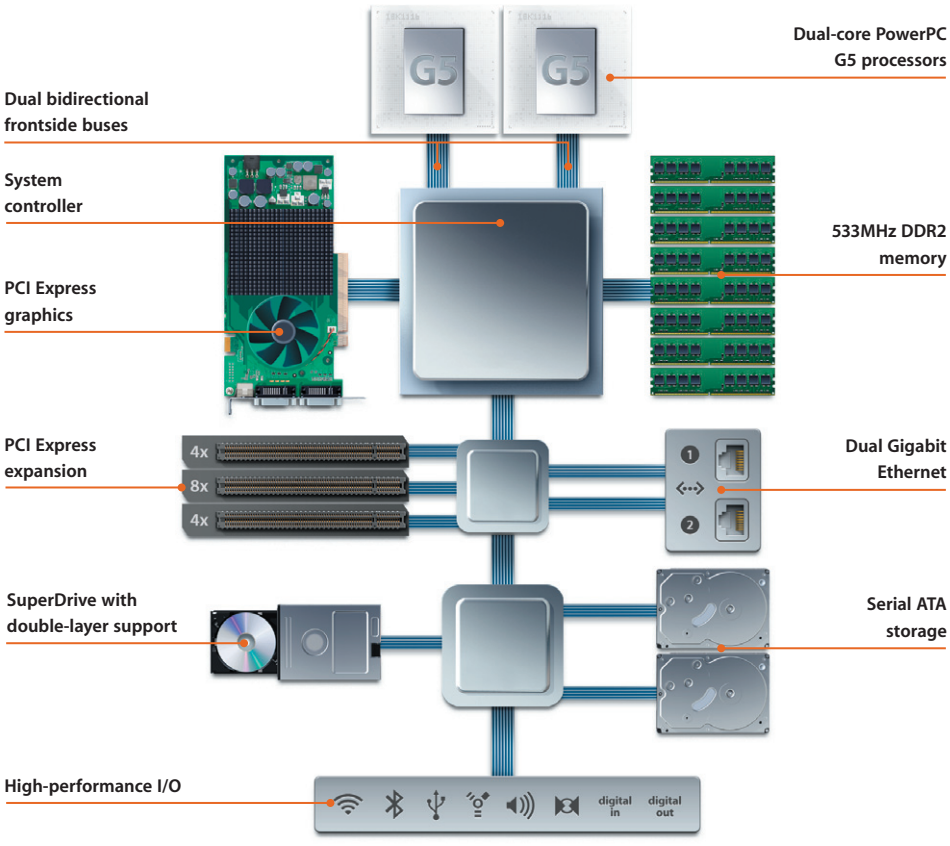
Applications can take even greater advantage of multiple cores when they are written to generate multiple threads (or self-contained tasks), known as multithreading. Many of today's applications are multithreaded, achieving up to 69 percent faster performance on a Power Mac G5 Quad right out of the box.[1]

As a user, you don't need to worry about symmetric multiprocessing or application threading—you'll just enjoy the enhanced performance.

PCI Express Architecture

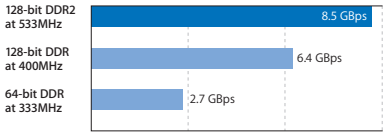
The new Power Mac G5 introduces a modern PCI Express architecture to the Mac platform, opening up a world of high-performance system technologies and peripherals. PCI Express paves the way for emerging solutions for media and networking, making it a future-savvy choice for your lab or studio.

Built into the Power Mac G5 architecture is an all-new system controller. This fast application-specific integrated circuit (ASIC) integrates a new lower-latency memory subsystem with support for ultrafast DDR2 main memory—plus 16-lane PCI Express graphics and the dual-channel, bidirectional frontside bus that made its debut in the original Power Mac G5.



533MHz DDR2 Main Memory

Up to 25 percent faster memory throughput
With support for DDR2 memory, data throughput on the new Power Mac G5 is 25 percent faster than previous Power Mac G5 models and up to three times faster than the Power Mac G4.



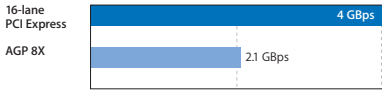
The new 128-bit memory controller in the Power Mac G5 supports DDR2 main memory running at speeds up to 533MHz. In addition to writing data at a double rate, or twice the rate of the clock speed, the memory controller increases efficiency by reordering read and write operations. By addressing two banks of SDRAM at the same time, the new Power Mac G5 can reach a memory throughput of up to 8.5 GBps. That represents a 25 percent increase over the latest Power Mac G5 and triple the throughput of the fastest Power Mac G4.

With its 64-bit processor architecture, the Power Mac G5 can address more memory than any previous Macintosh and many desktop PCs. All Power Mac G5 systems can hold up to eight 2GB DIMMs for up to 16GB of memory. For users in mission-critical and compute-intensive environments, there's also the option of ECC (Error Correction Code) main memory, which allows automatic correction of single-bit errors and detection of multiple-bit errors.

This high-speed, high-capacity memory architecture enables graphics, video, audio, and scientific applications to run radically faster. Enormous files and data sets can be loaded into RAM for rapid access by the PowerPC G5—without having to access system storage. Data can be retrieved from memory 40 times faster than from the hard drive. In fact, accessing the first critical word of data from memory is 60,000 times faster than from a hard drive, so manipulation and analysis of data can be performed at remarkable speeds.

PCI Express Graphics

Almost twice the graphics throughput
The 16-lane PCI Express graphics interface increases throughput to up to 4 GBps, almost double that of AGP 8X in previous Power Mac G5 models.

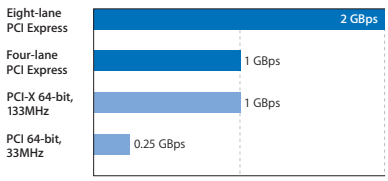


With the introduction of PCI Express architecture comes a new 16-lane PCI Express graphics interface that supports the latest graphics controllers and delivers up to 4 GBps of data throughput. By supplying up to 150 watts of power to the primary graphics processing unit, the new Power Mac G5 provides the headroom for high-performance, next-generation graphics processors and applications, enabling even higher resolutions for stunning realism.

For more information about graphics cards, Apple displays, and graphics technologies, see the "Workstation Graphics" section.

PCI Express Expansion

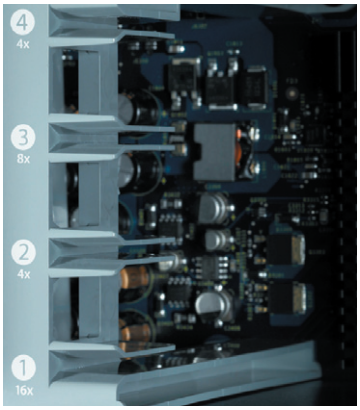
Up to twice the PCI throughput
PCI Express delivers a radical increase in throughput compared with the expansion technologies on previous Power Mac G5 systems (PCI-X and PCI) and Power Mac G4 systems (PCI).



The all-new PCI Express architecture allows you to customize your Power Mac G5 to the needs of your workflow—providing tremendous power and productivity in a single system. As your needs change, you'll have the flexibility to add solutions for emerging workflow scenarios, such as HD video and next-generation networking.

Modern serial expansion architecture
PCI Express is a modern industry standard sponsored by the Peripheral Component Interconnect Special Interest Group (PCI SIG). Because older parallel technologies placed multiple devices on a single bus, the slowest device determined the speed of the entire bus. A serial technology, PCI Express guarantees each device dedicated bandwidth to and from the system controller.

PCI Express communicates in 250-MBps "data lanes." PCI Express cards and slots are defined by their bandwidth, or number of data lanes—typically one lane, four lanes, eight lanes, or 16 lanes. At 250 MBps per lane, a four-lane slot can transfer data at up to 1 GBps and an eight-lane slot, up to 2 GBps—approximately twice as fast as a 133MHz PCI-X slot.



Each Power Mac G5 system includes four PCI Express slots.

Three expansion slots
In addition to the 16-lane graphics slot, the Power Mac G5 features three PCI Express expansion slots: two four-lane slots and one eight-lane slot. Each slot uses a standard connector that can accommodate a card of any size. This means a four-lane card works perfectly in an eight-lane slot. If the card has more lanes than the slot, the card adjusts to the bandwidth available and "downshifts" to that data rate.

With the high-bandwidth architecture in the new Power Mac G5, your system not only will achieve faster performance today, but will be ready for future technologies as well. For example, 10-gigabit networking technology, which can achieve up to 2.5 GBps of data throughput, will require an eight-lane slot. This promises to be an ideal solution for working with uncompressed HD video, which demands over 120 MBps per individual stream—and far more in a multiple-stream or multiple-camera environment.

Support for up to eight displays
Because both graphics and expansion slots use the same PCI Express standard, you can install a PCI Express graphics card in any PCI Express slot. That means a single Power Mac G5 can support four, six, or even eight displays with the addition of multiple NVIDIA GeForce 6600 graphics cards.

Dual Gigabit Ethernet

Two independently configurable 10/100/1000BASE-T (Gigabit) Ethernet interfaces deliver tremendous networking bandwidth. Each Gigabit Ethernet controller in the new Power Mac G5 supports jumbo frames (packets of up to 9000 bytes), reducing system overhead and increasing throughput for all network activities. Virtual LAN tags (VLAN 802.1q) allow the Power Mac G5 to join multiple virtual networks, with a unique identification for each one. And with Ethernet link aggregation in Mac OS X, you can combine the bandwidth of the interfaces for doubled performance.

Dual Gigabit Ethernet delivers the massive throughput required for many professional networking needs. You'll be able to support an isolated management network that's independent of a client services network, work in a SAN environment that requires independent networks for metadata and general networking, or provide the high-speed network interconnect required in many cluster computing environments.

High-Performance I/O

The Power Mac G5 architecture uses the HyperTransport protocol to integrate I/O subsystems and connect them to the system controller. Serial ATA, FireWire, USB, audio, and wireless technologies are integrated through two bidirectional 800MHz HyperTransport interconnects for a maximum throughput of 1.6 GBps, providing ample throughput for a host of peripheral devices.

Serial ATA storage
Serial ATA is the industry-standard storage interface, replacing the Parallel ATA interface. Designed to keep pace with the demands of digital video creation and editing, audio storage and playback, and other data-intensive applications, Serial ATA supports 1.5-Gbps throughput per channel (equivalent to a data rate of 150 MBps).

The Power Mac G5 can hold two internal 500GB Serial ATA drives for a total capacity of 1TB of storage.[2] Each drive is on an independent bus, so there's no competition for drive performance as with Parallel ATA. Performance is improved even further when drives are striped using software RAID in Mac OS X.

FireWire and USB 2.0

One of the most versatile standards ever developed, FireWire makes it easy to connect high-bandwidth devices such as DV cameras, hard drives, and high-performance imaging peripherals. And since FireWire cables carry power, the Power Mac G5 can recharge a portable device's batteries, even while it's in use. FireWire 800 doubles the throughput of the original FireWire 400, from 400 to 800 Mbps.[4] The FireWire 800 port can also connect to FireWire 400 devices using the appropriate 9-pin-to-6-pin or 9-pin-to-4-pin cable. What's more, FireWire 800 works over distances of up to 100 meters—perfect for remote devices.

USB ports allow you to connect printers, scanners, graphics tablets, keyboards, microphones, iPod players, speakers, joysticks, and other industry-standard input and output devices.

Each system has one FireWire 400 port on the front, one FireWire 400 port on the back, a FireWire 800 port on the back, and four USB 2.0 ports—one on the front and three on the back—plus two USB 1.1 ports on the keyboard.

Wireless connections

For wireless communications, an antenna is built into the Power Mac G5—just add optional AirPort Extreme and Bluetooth technologies. AirPort Extreme allows you to create an ad hoc network, share files with a wireless-enabled portable computer, or stream music to your stereo using an AirPort Express Base Station.[3] Bluetooth 2.0 + EDR (Enhanced Data Rate) allows short-range wireless connections—at data rates up to 3 Mbps—to a variety of Bluetooth-enabled digital devices, such as cell phones, personal digital assistants, printers, and Apple's wireless keyboard and mouse. You can even synchronize contacts between Bluetooth-equipped cell phones, PDAs, and Mac OS X Address Book.

For more information, see www.apple.com/airport and www.apple.com/bluetooth.

SuperDrive with double-layer support

The SuperDrive built into every Power Mac G5 reads and writes to a wide variety of DVD and CD media, including double-layer (DVD+R DL) discs capable of holding up to 8.5GB of data.

Versatile CD and DVD burning
The industry-standard SuperDrive writes to and reads dozens of CD and DVD formats.

- Writes DVD-R discs at up to 16x speed
- Writes DVD+R DL discs at up to 6x speed
- Reads DVDs at up to 16x speed
- Writes CD-R and CD-RW discs at up to 24x speed
- Reads CDs at up to 32x speed

While traditional single-layer DVD-R discs hold up to 4.7GB of data, double-layer discs have two layers of data, one of them semitransparent. The SuperDrive in the Power Mac G5 can read and write on either layer, almost doubling the storage space. This means you can author discs with over 3.5 hours of video encoded in standard MPEG-2 format on one DVD+R DL disc, compared with 2 hours of video on a standard DVD-R disc.

This added capacity is increasingly important as you design DVDs with more advanced features—such as additional languages, multiple soundtracks, and supplementary video angles—which require even greater disc capacity. For professional photographers, double-layer DVDs make an excellent medium for storing large numbers of high-resolution photographs.

Analog and digital audio

The Power Mac G5 features a comprehensive set of audio capabilities not commonly found in personal computers. State-of-the-art optical digital audio input and output ports use the S/PDIF (Sony/Philips Digital Interface) protocol over Toslink cables for connecting to devices such as decks, receivers, digital instruments, and even home theater systems. The optical digital audio ports on the Power Mac G5 support stereo and 5.1 surround sound speaker systems. Because optical digital audio transmits data as impulses of light rather than electrical signals, it delivers pristine digital sound.

Completing the audio features of the Power Mac G5 are high-quality analog stereo audio line-level input and output ports for connecting self-powered microphones and analog audio decks and devices. An internal speaker is included, and a minijack on the front panel makes it easy to plug in headphones for individual listening.

See page 28 for detailed audio specifications.

Workstation Graphics

The NVIDIA Quadro FX 4500 features two dual-link DVI ports, a stereo 3D port, and a large 512MB GDDR3 frame buffer for realistic and hyper-responsive graphics.

From 3D modeling applications to Mac OS X features like Exposé, Mac users enjoy fluid onscreen performance every minute of the day. PCI Express graphics in the new Power Mac G5 combine with state-of-the-art graphics technologies in Mac OS X Tiger to deliver even more cutting-edge capabilities.

A new lineup of PCI Express graphics cards provides professional capabilities and programmable graphics choices at all levels. Every Power Mac G5 supports two displays and can be expanded to drive an array of up to eight displays.[5] Best of all, for cutting-edge workstation graphics and the option of 3D stereo-in-a-window,[6] Apple introduces Power Mac G5 users to the Quadro FX 4500 card from NVIDIA.

Your ideas are transformed into reality when you add one—or several—crystal-clear Apple Cinema Displays to your Power Mac G5. This family of widescreen LCD displays delivers impressive image quality, enabling an all-digital, color-managed workflow not available on other platforms.

Advanced Graphics Options

With the introduction of PCI Express architecture comes a new lineup of 16-lane PCI Express graphics cards for the Power Mac G5. Choose a standard configuration equipped with a card for general graphics applications—or upgrade to a high-performance card for ultraresponsive graphics and true onscreen stereo 3D, perfect for scientific visualization and 3D design.

NVIDIA GeForce 6600 LE and GeForce 6600
Standard Power Mac G5 configurations come with the GeForce 6600 LE or the GeForce 6600 from NVIDIA. These cards provide excellent all-around performance for creative applications and office productivity.

NVIDIA GeForce 7800 GT
If you need higher performance for motion graphics, animation, and 3D design and visualization, you'll likely want to upgrade to the NVIDIA GeForce 7800 GT. Designed to accelerate the latest creative applications and blockbuster games, the 7800 GT has a large 256MB frame buffer and very fast GDDR3 (Graphics Double Data Rate 3) SDRAM.

16-lane PCI Express
The 16-lane PCI Express graphics interface provides throughput of up to 4 GBps, almost double that of the AGP 8X standard. And by supplying up to 150 watts of power to the primary graphics processing unit, the new Power Mac G5 provides the headroom for high-performance, next-generation graphics processors and applications—enabling even higher resolutions for stunning realism.

NVIDIA Quadro FX 4500

If industrial-strength 3D design work, stereo 3D visualization, or using two 30-inch Apple Cinema HD Displays is at the top of your wish list, you can configure your Power Mac G5 with the NVIDIA Quadro FX 4500.[7] One of the most sophisticated graphics cards available, the Quadro FX 4500 is an ideal choice for advanced design and visualization. It features:

- An integrated stereo 3D port, so scientists can use goggles for stereo-in-a-window visualization applications[6]
- Hardware support for anti-aliased points and lines, accelerated clip planes, and two-sided lighting
- Two dual-link DVI ports for connecting two 30-inch Apple Cinema HD Displays, delivering the largest workspace available using a single graphics card

Graphics card specifications

	GeForce 6600 LE	GeForce 6600	GeForce 7800 GT	Quadro FX 4500
Card interface	16-lane PCI Express	16-lane PCI Express	16-lane PCI Express	16-lane PCI Express
Memory interface	128-bit	128-bit	256-bit	256-bit
Frame buffer memory	128MB GDDR SDRAM	256MB GDDR SDRAM	256MB GDDR3 SDRAM	512MB GDDR3 SDRAM
Memory bandwidth	6.4 GBps	8 GBps	32 GBps	33.6 GBps
Vertices per second	225 million	225 million	700 million	181 million triangles
Fill rate (texels per second)	1.2 billion	2.4 billion	8 billion	10.8 billion
Ports	One single-link DVI and one dual-link DVI	One single-link DVI and one dual-link DVI	One single-link DVI and one dual-link DVI	Two dual-link DVI and one stereo port
Slots occupied	One	One	One	Two

Choosing a graphics card

Which card is right for you? More powerful graphics processors and faster, larger frame buffers perform 2D and 3D operations more quickly. When selecting a graphics card, consider your primary uses, along with the following:

- Memory bandwidth determines how fast images and textures can be accessed by the graphics processor from its own memory. The higher the bandwidth, the more capable the card is of supporting real-time, complex 3D images.
- Vertices are the key building blocks for 3D images in the OpenGL graphics environment in Mac OS X. More vertices means greater complexity, resulting in more realism onscreen.
- After a 3D object is assembled from the vertices, it must be filled. Each 3D object can contain many pixels, each with a different appearance based on the texture, lighting, and color being applied. The higher the fill rate, the more lifelike an object appears.
- Frame buffer memory, or video memory, stores the information being used by the graphics processor to create onscreen images. The faster the memory, the more capable the graphics card is of generating lifelike, complex 3D screens in real time. For best performance, choose GDDR3 memory, developed by the graphics industry for intensive 3D applications. Note that larger frame buffers also improve support for a multiple-display configuration in which large, complex screens are created for both displays.

- All Power Mac G5 cards support two displays: one 20- or 23-inch Apple Cinema Display and one 30-inch Apple Cinema HD Display. If you want to connect your Power Mac G5 to two 30-inch Apple Cinema HD Displays—or use stereo 3D goggles—choose the workstation-class NVIDIA Quadro FX 4500.
- If you plan to install as many as three PCI Express cards in your Power Mac G5, you'll want to consider cards that occupy a single slot.

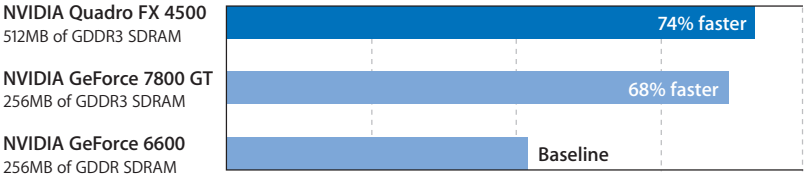
Core Image in Mac OS X
Built into Mac OS X, Core Image is an advanced image-processing technology that leverages the graphics processor for blistering-fast rendering performance. Effects and transitions can be expressed with a few lines of code. Core Image handles the rest, optimizing the path to the graphics processor. The result is real-time response as you select and apply filters.

Graphics performance

Each of the graphics card options available for the new Power Mac G5 provides excellent support for 2D and 3D operations in applications such as Motion and in games such as Halo.

Motion graphics. Motion, Apple's motion graphics design application, leverages the graphics processor to animate effects onscreen in real time. The test protocol measured the uncached playback, cached playback, and export to QuickTime of three projects: a filter test, an HDV green screen matte, and a particle effects test.

Motion 2 results
Visual effects rendering

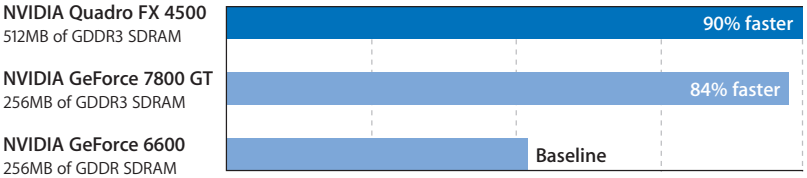


Percent faster than the previous model

The Power Mac G5 Quad configured with the NVIDIA Quadro FX 4500 was 74 percent faster than the same system configured with the NVIDIA GeForce 6600.*

3D gaming. 3D gaming involves realistic visualizations and rapid movements that require maximum processor performance and top-of-the-line graphics capabilities—all with more complexity and better texturing than ever before. Frame rates were measured using the game Halo, one of the most popular gaming titles on the market, which leverages the programmability features of the graphics card.

Halo results
1024-by-768 resolution, 32-bit color



Percent faster than the previous model

The Power Mac G5 Quad configured with the NVIDIA Quadro FX 4500 was 90 percent faster than the same system configured with the NVIDIA GeForce 6600.*

* Testing conducted by Apple in September 2005 using preproduction 2.5GHz Power Mac G5 Quad units. Motion tests included a mix of particle effects, green screen compositing, and filter effects. Halo 1.5.2 was tested using the Time Demo benchmark with advanced pixel shaders.

Certified by SWOP
SWOP, the organization that sets Specifications for Web Offset Printing, has certified the Apple Cinema Display for virtual color proofing. This means you can check color onscreen, without the wasted time and expense of producing and delivering hardcopy proofs.

Apple Cinema Displays

Featuring a compact footprint and elegant aluminum design, an Apple Cinema Display is the perfect match for your new Power Mac G5. The DVI interface transfers pure digital signals from computer to display, and each display includes two USB 2.0 and two FireWire 400 ports for connecting devices. You can even add an iSight camera to the top of the display using a sleek magnetic mount.

Designed for the creative workflow, Apple displays deliver stunning image quality not found in other flat panels. Each display features 100-pixel-per-inch resolution for an ideal balance of text readability and image crispness. Wide-viewing technology guarantees consistent and accurate color across a 170-degree viewing spectrum. Color quality is also superior, with a broad color gamut, high display brightness, and uniform color across the panel. All Apple Cinema Displays can be calibrated for color-managed workflows and will maintain consistent color and quality without frequent recalibration.

For more information, see www.apple.com/displays.

Choosing an Apple display
Apple offers a choice of three widescreen flat-panel displays:

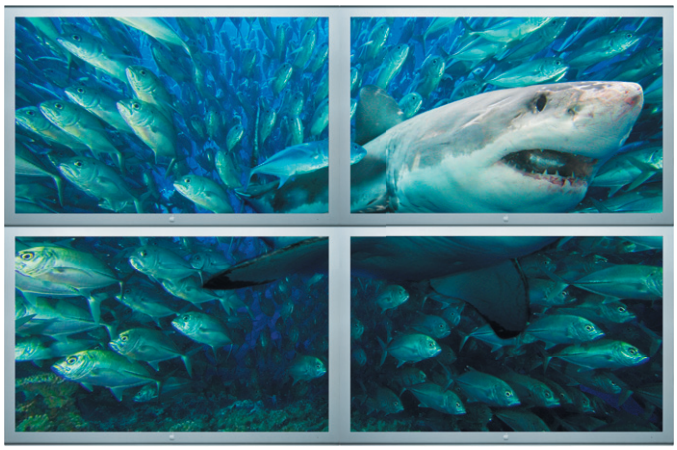
- The 20-inch Apple Cinema Display (1680-by-1050-pixel resolution) shows more than two full pages of graphics, layouts, and text—or DVD movies in wide format.
- The 23-inch Apple Cinema HD Display (1920-by-1200-pixel resolution) supports high definition content and stunning color for multipage layouts and video editing.
- The largest LCD ever designed for a personal computer, the astounding 30-inch Apple Cinema HD Display (2560-by-1600-pixel resolution) puts more than 4 million pixels at your fingertips.

Support for Multiple Displays

Connecting to other displays, TVs, VCRs, and projectors
A DVI to VGA Adapter is included with every Power Mac G5 for connecting to VGA displays, such as CRTs or projectors. Or you can order the Apple DVI to Video Adapter to connect to S-video and composite devices, such as TVs, VCRs, or overhead projectors with S-video or RCA (composite) connectors.[8]

Every Power Mac G5 graphics card supports two displays in extended desktop and video mirroring modes. Extended desktop mode lets you distribute work across two displays, allowing more room for viewing rich content and complex applications that use floating palettes and long timelines. For example, you can view Final Cut Pro on one display while watching the video output on the other. Video mirroring mode outputs the same information on both displays, which means you can control a presentation from one display while the audience watches it on a second display or projected image.

The possibilities get even more interesting when you connect more than two displays. For maximum productivity, extend your desktop across up to eight displays.[5] Or consider controlling a set of public information kiosks or constructing a multimedia museum exhibit from a single Power Mac G5 system.



Real-World Advantages

The new Power Mac G5 and Mac OS X deliver performance and platform advantages that make it the system of choice for professionals in the creative and scientific fields. With dual-core PowerPC G5 processors, a new PCI Express architecture, and workstation graphics features, this groundbreaking system opens up a wealth of possibilities for 2D and 3D designers, video and audio producers, scientists, and researchers.

Film and Video

No matter what the format—DV, SD, HDV, HD, or even film—the Power Mac G5 gives film and video professionals the freedom and power to create studio-quality projects.

- Dual-core and quad-core Power Mac G5 systems speed up editing and enhance multistream and multicam production using Final Cut Studio—supporting more simultaneous streams and real-time effects, as well as accelerating video processing and rendering.
- PCI Express graphics cards, such as the optional GeForce 7800 GT and Quadro FX 4500 from NVIDIA, boost motion graphics and animation performance in applications such as Motion, After Effects, Maya, and Modo.
- A host of integrated technologies allow you to customize a state-of-the-art studio: fast DDR2 memory expandable to 16GB, support for multiple Apple Cinema Displays, PCI Express expansion for Fibre Channel and video acquisition cards, and FireWire 800 for high-performance decks and devices.
- Fast encoding and a SuperDrive with double-layer support make it easy to author commercial-grade DVDs in record time using DVD Studio Pro.
- A workflow based on Mac OS X and QuickTime gives you the flexibility to author in any format, while XML extensibility lets you share projects between applications.

Use the new Apple Fibre Channel PCI Express Card to connect to Xserve RAID for high-performance, high-availability storage.

Xsan for video workflows
The Power Mac G5 is the perfect client for Xsan, Apple's enterprise-class storage area networking (SAN) solution. Xsan provides concurrent access to terabytes of storage on centralized Xserve RAID volumes from multiple computers—providing the high performance required by individual editors, as well as the stability and security valued by network administrators.

Use the new Apple Fibre Channel PCI Express Card to connect the Power Mac G5 to Xserve RAID and an Xsan network. This card runs at full bandwidth in a four-lane or eight-lane PCI Express slot. Built-in dual Gigabit Ethernet interfaces on the Power Mac connect to the metadata controller and network services—freeing up slots for specialized cards, such as the NVIDIA Quadro FX 4500 for accelerating effects and animation, a PCI Express video I/O card for input or preview of footage, or even an audio DSP or I/O card for sound editing.

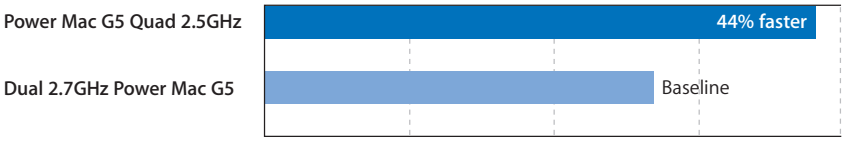
For more information on the Xsan video workflow, visit www.apple.com/xsan.

Video editing performance

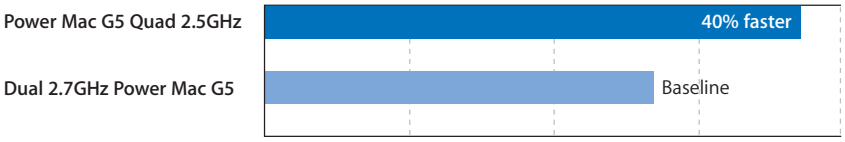
One of the final stages of any film or video project is the processor-intensive task of rendering. Apple measured the time to render a complex video project containing multiple effects and filters, including color corrections, transitions, compositing, and basic text treatments.

Final Cut Pro 5.0.2 rendering results

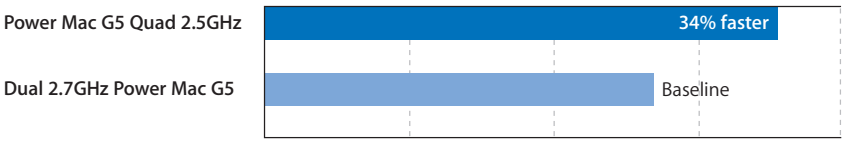
High definition video (HDV—1080i60) video rendering



Standard definition (SD) video rendering



Digital video (DV) video rendering



Percent faster than the previous model

The Power Mac G5 Quad rendered an HDV project 44 percent faster than the dual 2.7GHz Power Mac G5. Performance gains were similar for SD and DV projects.*

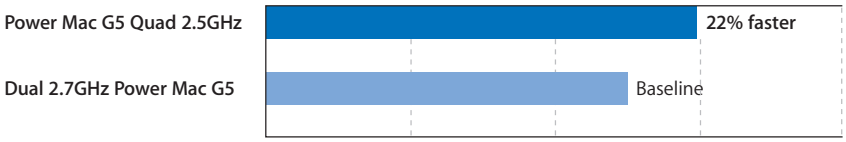
* Testing conducted by Apple in September 2005 using preproduction 2.5GHz Power Mac G5 Quad units; all other systems were shipping units.

Video encoding performance

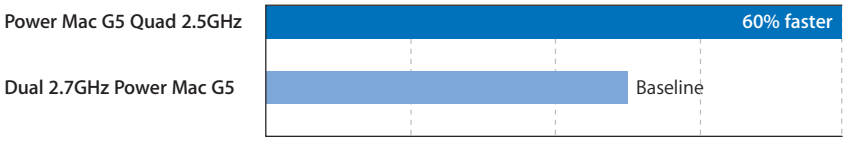
Apple measured the time to encode a video project from various native formats to MPEG-2, the most common format for commercial DVD titles.

Final Cut Pro 5.0.2 encoding results

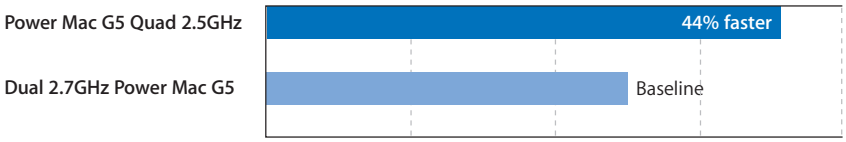
High definition video (HDV—1080i60) MPEG-2 encoding



Standard definition (SD) MPEG-2 encoding



Digital video (DV) MPEG-2 encoding



Percent faster than the previous model

The Power Mac G5 Quad encoded an HDV project 22 percent faster than the dual 2.7GHz Power Mac G5. Performance gains were even better for SD and DV encoding: The Power Mac G5 Quad encoded SD video 60 percent faster than the dual 2.7GHz Power Mac G5—and encoded DV projects 44 percent faster.*

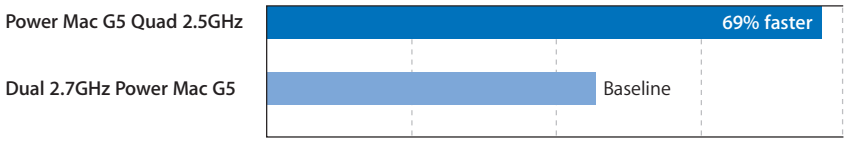
* Testing conducted by Apple in September 2005 using preproduction 2.5GHz Power Mac G5 Quad units; all other systems were shipping units.

Effects and animation performance

Video editors and producers add innovative motion graphics and effects to film, video, DVD, and web projects using tools like Motion, Adobe After Effects, LightWave 3D, and Cinema 4D. To demonstrate the performance advantages of quad-core processors, Apple measured the time to render effects using three application tests.

After Effects 6.5.1 results

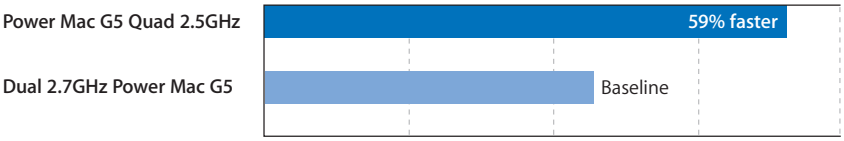
Visual effects rendering



The Power Mac G5 Quad performed the Nightflight rendering test 69 percent faster than the dual 2.7GHz Power Mac G5.*

LightWave 3D 8.2.1 results

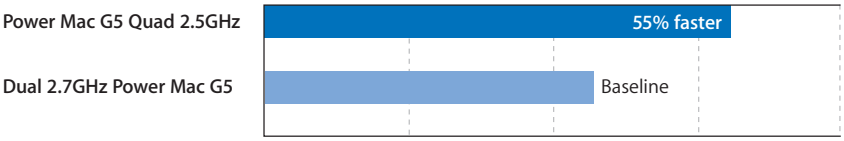
3D rendering



The Power Mac G5 Quad rendered the LightWave 3D scene 59 percent faster than the dual 2.7GHz Power Mac G5.*

Cinebench results

Multiple-processor rendering



The Power Mac G5 Quad performed the Cinebench rendering test 55 percent faster than the dual 2.7GHz Power Mac G5.*

* Testing conducted by Apple in September 2005 using preproduction 2.5GHz Power Mac G5 Quad units; all other systems were shipping units. After Effects test file was Nightflight. LightWave benchmark scene was Skull_Head_Newest.

Xcode development tools
Mac OS X comes with Xcode, a suite of integrated technologies that support custom development of 64-bit applications and autovectorization of your code.

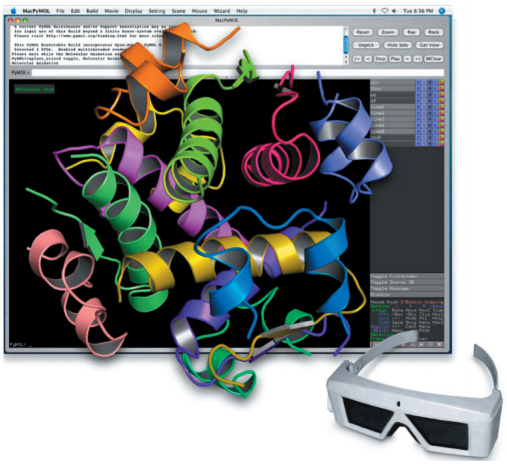
Science and Technical Computing

The Power Mac G5 gives scientific researchers the ability to achieve fast results. Whether you're doing molecular modeling with PyMOL, searching for DNA alignments with BLAST, analyzing statistics with SPSS, or modeling equations with Mathematica, you'll make discoveries in record time.

- With four 64-bit G5 processor cores, four Velocity Engine units, and eight double-precision floating-point units, you'll see dramatic acceleration of vectorized and floating-point-intensive applications such as HMMER and BLAST.
- The optional NVIDIA Quadro FX 4500 graphics card supports stereo 3D visualization in a window for complex data analysis.[6]
- Up to 16GB of main memory with an ECC option makes light work of enormous tasks, while PCI Express expansion supports Fibre Channel interconnects, the latest data collection devices, and multiple graphics cards for an array of up to eight Apple Cinema Displays.[5]
- UNIX-based Mac OS X allows you to run complex scientific applications and command-line tools alongside essential productivity applications, such as Microsoft Excel and Adobe Photoshop—all on the same computer and operating system.

Scientific visualization and stereo 3D
In fields such as molecular modeling, X-ray crystallography, computational chemistry, aerial mapping, or medical imaging, users need to visualize more information than can be represented in a conventional planar display. With the help of an added dimension and stereoscopic technologies, researchers can comprehend extremely large data sets, such as the construct of molecules in a drug or a virus, or extremely complex data, such as a detailed aerial photograph.

The optional NVIDIA Quadro FX 4500 graphics card features a stereo 3D graphics port, enabling you to use stereo 3D goggles, such as those from Stereo Graphics Corporation, to view an added dimension on your CRT. Stereo-in-a-window support in Mac OS X further enhances visualization, allowing you to designate a quadrant of the display for stereo visualization, while using the other areas of the display concurrently to control the model, edit data, or make notations.[6]



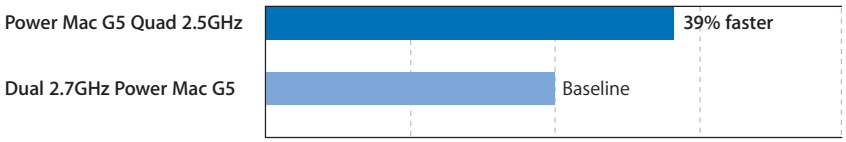
Thanks to PCI Express expansion, which supports industry-standard PCI Express graphics cards in all four slots, you can connect the new Power Mac G5 to an array of large displays. Each graphics card has two DVI ports, which means a single system can control up to eight Apple Cinema Displays,[5] providing an impressive view of geological or meteorological data.

Scientific analysis performance

To demonstrate the performance advantages of the Power Mac G5 Quad for processor-intensive scientific analysis, Apple used Bioinformatics Benchmark System version 3 (or BBSv3), an Xcode development test, and the MathematicaMark5.2 benchmark built into Mathematica.

Bioinformatics Benchmark System (BBSv3) results

Multiple-processor test summary

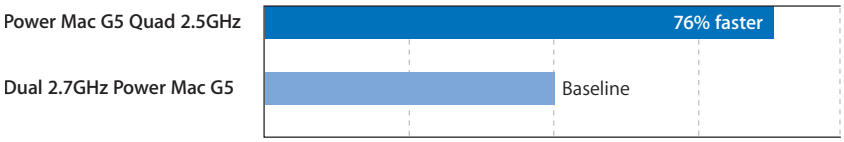


Percent faster than the previous model

The Power Mac G5 Quad performed the BBSv3 multiple-processor test—based on HMMER and BLAST, using current data sets, from the bioinformatics community—39 percent faster than the dual 2.7GHz Power Mac G5.*

Xcode 2.1 results

Build project

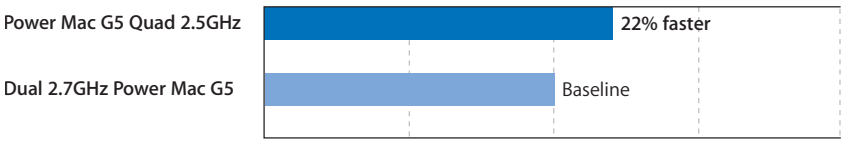


Percent faster than the previous model

The Power Mac G5 Quad completed an Xcode project build 76 percent faster than the dual 2.7GHz Power Mac G5.*

Mathematica 5.2 results

MathematicaMark5.2



Percent faster than the previous model

Using the MathematicaMark5.2 benchmark, the Power Mac G5 Quad outperformed the dual 2.7GHz Power Mac G5 by 22 percent.*

* Testing conducted by Apple in September 2005 using preproduction 2.5GHz Power Mac G5 Quad units; all other systems were shipping units. Bioinformatics Benchmark System test results were based on BBSv3, available at www.scalableinformatics.com, using July 2005 FASTA databases; NCBI version 2.2.11 BLAST, available at www.ncbi.nlm.nih.gov/blast; and HMMER version 2.3.2, available at hmmer.wustl.edu.

Design and Print

Bring your ideas to life with the new Power Mac G5 and publishing tools such as Adobe Creative Suite, QuarkXPress, and Macromedia Studio. Whether you're designing for print or for the web, you can realize your ideas as fast as you can imagine them.

- New dual-core and quad-core Power Mac G5 systems crunch through huge images and layouts. With symmetric multiprocessing, you can burn DVDs, generate PDFs, or print in the background while you continue to create.
- Up to 16GB of main memory enables fast manipulation of massive media files.
- Fast PCI Express graphics cards and 3D-savvy applications like Maya, Modo, Motion, and After Effects allow you to add movement and dimension to your designs.
- With four PCI Express slots and two DVI ports on each graphics card, the new Power Mac G5 can connect to up to eight Apple Cinema Displays, so your imagination has an ultralarge playground.[5]
- Integrated dual Gigabit Ethernet and high-speed I/O provide high-bandwidth connections to networks, printers, scanners, cameras, and storage devices.
- The Quartz graphics engine in Mac OS X renders breathtaking content across mediums, while ColorSync ensures perfect color from capture to edit to output. Mac OS X Tiger also includes Automator, which allows you to automate repetitive tasks to streamline your workflow.

Professional color management
The Power Mac G5, Mac OS X Tiger, and an Apple Cinema Display enable designers to implement an entirely digital, color-managed workflow—improving the quality of printed output while saving time and money. Apple's groundbreaking ColorSync technology, based on the International Color Consortium (ICC) standard for color management, is built into every phase of a Mac-based design workflow. From capture to edit to output, you can be sure that your color translates accurately from one device to another.

Apple Cinema Displays work as your virtual color palette, with advanced panel technology for flicker-free viewing and twice the brightness, sharpness, and contrast of a CRT display. Use a calibration device from GretagMacbeth or X-Rite to calibrate your Apple Cinema Display, and you'll enjoy consistent color proofs, reduced express shipping expenses, and fewer mishaps in the proofing process.

For more information on how color management in Mac OS X can enhance your workflow and improve final output, visit www.apple.com/pro/color.

x-rite
gretagmacbeth
YOUR COLOR. PRECISELY.

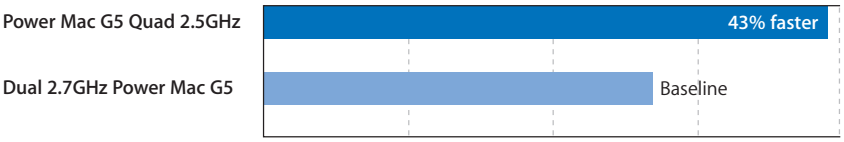
Color calibration
For an integrated, color-managed workflow, choose a calibration device from GretagMacbeth or X-Rite to create custom ColorSync profiles for your Apple Cinema Displays.

Image editing performance

To demonstrate the superiority of the Power Mac G5 Quad, Apple conducted tests using Adobe Photoshop CS2 (9.0), the application most widely used by creative professionals.

Photoshop CS2 (9.0) results

45-action test



Percent faster than the previous model

The Power Mac G5 Quad ran the 45 Photoshop actions 43 percent faster than the dual 2.7GHz Power Mac G5.*

Music and Audio

Innovative tools for the Mac platform—such as Logic Pro, Soundtrack Pro, Digidesign Pro Tools, MOTU Digital Performer, and Steinberg Cubase SX and Nuendo—provide composers and sound designers with a wealth of software for capturing every inspiration. With the new Power Mac G5, you'll have even more power at your fingertips to compose, record, edit, mix, and perform.

- Dual-core PowerPC G5 processors effortlessly synthesize instruments and apply effects.
- Up to 16GB of memory provides ample bandwidth to compose using an unprecedented number of tracks.
- PCI Express expansion supports state-of-the-art audio DSP and I/O solutions.
- Built-in optical digital and analog audio ports support both new and legacy hardware, and convenient FireWire and USB ports let you connect to virtually any audio, MIDI, and storage devices.
- Support for multiple displays enables you to spread out your tools and timelines.
- Mac OS X with Core Audio allows you to run several applications simultaneously, while Audio Units provide a robust plug-in protocol designed to work seamlessly across host applications.

Audio in Mac OS X

Mac OS X integrates a range of audio technologies into a modern platform, delivering stunning audio quality from 24kHz to 192kHz, outstanding performance, and ease of use for musicians, composers, sound designers, and audio editors. A new plug-in architecture called Audio Units allows plug-ins to be used across Mac OS X audio applications. Apple supplies several Audio Units in Mac OS X, including one that adjusts timing without affecting pitch, a Velocity Engine–optimized reverb, and a matched pair that streams audio over a network. Also integrated are MIDI (Musical Instrument Digital Interface) Services for increased stability and performance, as well as Audio MIDI Setup for managing your MIDI needs and defining a systemwide MIDI configuration that's available to all of your applications.

* Testing conducted by Apple in September 2005 using preproduction 2.5GHz Power Mac G5 Quad units; all other systems were shipping units. File size was 400MB; system memory was 4GB.

Optical digital audio specifications

	Input	Output
Data format	S/PDIF (IEC60958-3)	S/PDIF (IEC60958-3)
Connector type	Toslink optical (IEC60874-17)	Toslink optical (IEC60874-17)
Sample rates		
– External clock mode	32kHz to 96kHz	32kHz to 96kHz
– Internal clock mode	32kHz to 96kHz	32kHz to 96kHz
Bits per sample	16 or 24	16 or 24
Signal-to-noise ratio		
– External clock mode	Greater than 130 dB	Greater than 130 dB
– Internal clock mode	Greater than 110 dB	Greater than 130 dB
Total harmonic distortion		
– External clock mode	Less than 0.00003 percent	Less than 0.00003 percent
– Internal clock mode	Less than 0.0003 percent	Less than 0.00003 percent

Analog input specifications

	Line input
Sample rates	32kHz, 44.1kHz, or 48kHz
Bits per sample	16 or 24
Jack type	3.5-mm stereo
Input impedance	Greater than 47K ohms
Maximum input voltage	$2V_{rms}$ (+8.2 dBu)
Frequency response	20Hz to 20kHz, +0.5 dB/–3 dB
Signal-to-noise ratio	Greater than 90 dB
Total harmonic distortion	Less than 0.006 percent

Analog output specifications

	Line output	Headphone jack
Sample rates	32kHz, 44.1kHz, or 48kHz	32kHz, 44.1kHz, or 48kHz
Bits per sample	16 or 24	16 or 24
Jack type	3.5-mm stereo	3.5-mm stereo
Output impedance	24 ohms	24 ohms
Output voltage	$1.4V_{rms}$ (+4.1 dBu)	$1.4V_{rms}$ (+4.1 dBu)
Frequency response	20Hz to 20kHz, +0.5 dB/–3 dB	20Hz to 20kHz, +0.5 dB/–3 dB
Signal-to-noise ratio	Greater than 90 dB	Greater than 90 dB
Total harmonic distortion	Less than 0.01 percent	Less than 0.01 percent
Output power (into 32 ohms)	—	20 mW

Based on typical performance specifications.

To learn more about audio and the Mac platform, visit www.apple.com/pro/audio.

Configurations and Options

Standard Configurations

Apple offers Power Mac G5 systems to meet the needs of professionals, media producers, designers, educators, scientists, and researchers. The following standard configurations are available through the Apple Store and Apple Authorized Resellers.

	Power Mac G5 Dual	**Power Mac G5 Dual**	**Power Mac G5 Quad**
Order number	M9590LL/A	M9591LL/A	M9592LL/A
Processor	Dual-core 2GHz PowerPC G5	Dual-core 2.3GHz PowerPC G5	Two dual-core 2.5GHz PowerPC G5
L2 cache	1MB per core	1MB per core	1MB per core
Frontside bus	1GHz	1.15GHz	1.25GHz per processor
Main memory	512MB of 533MHz DDR2 SDRAM (PC2-4200); supports up to 16GB		
Standard graphics	NVIDIA GeForce 6600 LE with 128MB of GDDR SDRAM, one single-link DVI port, and one dual-link DVI port	NVIDIA GeForce 6600 with 256MB of GDDR SDRAM, one single-link DVI port, and one dual-link DVI port	
Optional graphics	NVIDIA GeForce 7800 GT with 256MB of GDDR3 SDRAM, one single-link DVI port, and one dual-link DVI port; or NVIDIA Quadro FX 4500 with 512MB of GDDR3 SDRAM, two dual-link DVI ports, and one stereo 3D port (occupies 16-lane PCI Express slot and adjacent PCI Express slot)		
Hard drive	160GB 7200-rpm Serial ATA[2]	250GB 7200-rpm Serial ATA[2]	250GB 7200-rpm Serial ATA[2]
Optical drive	16x SuperDrive with double-layer support (DVD+R DL/DVD±RW/CD-RW)		
PCI Express expansion	Three open PCI Express expansion slots: two four-lane slots and one eight-lane slot		
Ports and bays	One FireWire 800 port, two FireWire 400 ports (one on front), four USB 2.0 ports (one on front), two USB 1.1 ports (on keyboard), two internal hard drive bays (one occupied)		
Audio	Optical digital audio input, optical digital audio output, analog audio input, analog audio output, front headphone minijack and speaker		
Networking	Dual Gigabit Ethernet ports; optional AirPort Extreme[3] and Bluetooth 2.0 + EDR; optional external Apple USB Modem		
Software	Mac OS X, Spotlight, Dashboard, Mail, iChat AV, Safari, Address Book, QuickTime, iLife (includes iTunes, iPhoto, iMovie HD, iDVD, and GarageBand), iCal, DVD Player, Classic environment, Art Directors Toolkit X, FileMaker Pro Trial, GraphicConverter, Microsoft Office 2004 for Mac Test Drive, OmniGraffle, OmniOutliner, QuickBooks New User Edition, Zinio Reader, Xcode Development Tools		
Service and support	90 days of toll-free telephone support and one-year limited warranty		
Also included	Apple Keyboard, Mighty Mouse, USB keyboard extension cable, DVI to VGA adapter		

Build-to-Order Options

Order a custom-configured computer from the Apple Store or an Apple Authorized Reseller. Build-to-order options can include the following:

- Memory (PC2-4200 DDR2 SDRAM; installed in pairs): 512MB, 1GB, 2GB, 4GB, 8GB, or 16GB; 1GB or more available in choice of ECC or NECC
- Hard drives (Serial ATA): 160GB, 250GB, 500GB, two 500GB[2]
- Graphics: NVIDIA GeForce 6600 LE with 128MB of GDDR SDRAM, NVIDIA GeForce 6600 with 256MB of GDDR SDRAM, NVIDIA GeForce 7800 GT with 256MB of GDDR3 SDRAM, or NVIDIA Quadro FX 4500 with 512MB of GDDR3 SDRAM (Quadro FX 4500 occupies 16-lane PCI Express slot and adjacent PCI Express slot)
- Wireless: AirPort Extreme and Bluetooth technologies, AirPort Express Base Station, AirPort Extreme Base Station, Apple Wireless Keyboard and Mouse[9]
- Expansion: Apple Fibre Channel PCI Express Card (for connecting an Xserve RAID storage system)

Apple Displays and Adapters

To complete your Power Mac G5 system, you can choose from Apple's family of all-digital, flat-panel displays.

- Apple Cinema Display (20-inch flat panel), order number M9177LL/A
- Apple Cinema HD Display (23-inch flat panel), order number M9178LL/A
- Apple Cinema HD Display (30-inch flat panel), order number M9179LL/A
- ADC to DVI Adapter, order number T2774G/A
- DVI to Video Adapter (for connecting S-video or composite devices), order number M9267G/A[8]

Extended Service and Support

Purchase the AppleCare Protection Plan to extend your service and support to up to three full years from the purchase date of your computer. The plan provides support for your Mac, the Mac OS, and many Apple consumer applications, so just one phone call can help resolve most issues. You can also enroll one Apple display for coverage, provided that your Power Mac G5 and display are purchased together. For more information, visit www.apple.com/support/products.

Technical Specifications

Processing

- Single 2GHz, single 2.3GHz, or dual 2.5GHz dual-core PowerPC G5 microprocessors
- PowerPC processor architecture with 64-bit data paths and registers; each core includes:
  - 1MB on-chip L2 cache running at processor speed (total 2MB per processor)
  - Parallel data structure supporting up to 215 simultaneous in-flight instructions
  - Simultaneous issue of up to 10 out-of-order operations
  - Dual-pipeline Velocity Engine for 128-bit single-instruction, multiple-data (SIMD) processing
  - Two independent double-precision floating-point units
  - Advanced three-component branch prediction logic
- Native support for 32-bit application code
- Single 1GHz, single 1.15GHz, or dual 1.25GHz 64-bit DDR bidirectional frontside buses
- Point-to-point system controller

Memory

- 128-bit memory controller and data paths
  - 512MB of 533MHz DDR2 SDRAM (PC2-4200)
  - Eight DIMM slots supporting up to 16GB of main memory
- Support for the following DIMMs (in pairs):
  - 256MB DIMMs (64-bit-wide, 512-Mbit)
  - 512MB DIMMs (64-bit-wide, 512-Mbit)
  - 1GB DIMMs (64-bit-wide, 512-Mbit or 1-Gbit)
  - 2GB DIMMs (64-bit-wide, 1-Gbit)
- ECC memory available in configurations with 1GB or more (build-to-order option)

Graphics and displays

- 16-lane PCI Express graphics slot with one of the following graphics cards installed:
  - NVIDIA GeForce 6600 LE with 128MB of GDDR SDRAM, one single-link DVI port, and one dual-link DVI port
  - NVIDIA GeForce 6600 with 256MB of GDDR SDRAM, one single-link DVI port, and one dual-link DVI port
  - NVIDIA GeForce 7800 GT with 256MB of GDDR3 SDRAM, one single-link DVI port, and one dual-link DVI port (build-to-order option)
  - NVIDIA Quadro FX 4500 with 512MB of GDDR3 SDRAM, two dual-link DVI ports, and one stereo 3D port (build-to-order option; occupies 16-lane PCI Express slot and adjacent PCI Express slot)
- Support for graphics cards that require up to 150W
- Support for digital resolutions up to 1920 by 1200 pixels; dual-link DVI ports support up to 2560 by 1600 pixels

- Support for analog resolutions up to 2048 by 1536 pixels
- DVI to VGA Adapter included
- Dual-display support for extended desktop and video mirroring modes
- Support for up to two Apple flat-panel displays for each graphics card installed[5]

Storage

- Two 3.5-inch hard drive bays, each with a 150-MBps Serial ATA controller; one of the following is installed:
  - One 160GB 7200-rpm Serial ATA; 8MB memory buffer
  - One 250GB 7200-rpm Serial ATA; 8MB memory buffer
  - One or two 500GB 7200-rpm Serial ATA; 16MB memory buffer (build-to-order option)
- 16x SuperDrive with double-layer support (DVD+R DL/DVD±RW/CD-RW); writes DVD-R discs at up to 16x speed, writes DVD+R DL discs at up to 6x speed, reads DVDs at up to 16x speed, writes CD-R and CD-RW discs at up to 24x speed, reads CDs at up to 32x speed

PCI expansion

- Two open full-length four-lane PCI Express slots
- One open full-length eight-lane PCI Express slot
- PCI Express cards of any size supported in all slots

Communications

- Two independent 10/100/1000BASE-T Ethernet (RJ-45) interfaces with support for jumbo frames
- Optional AirPort Extreme and Bluetooth 2.0 + EDR (build-to-order option or installed by Apple Authorized Service Provider)
  - AirPort Extreme: Based on IEEE 802.11g standard and Wi-Fi Certified for 802.11g and 802.11b interoperability[3]
  - Bluetooth: Support for Enhanced Data Rate, or data rates up to 3 Mbps
- Optional external Apple USB Modem (RJ-11)

Peripherals and audio

- One FireWire 800 port; two FireWire 400 ports (one on front panel; 15W total power)
- Four USB 2.0 ports (one on front panel); two USB 1.1 ports on included keyboard
- Front headphone minijack and speaker
- Optical digital audio input and output Toslink connectors
- Stereo analog line-level input and output minijacks

Electrical and environmental requirements

- Meets ENERGY STAR requirements
- Line voltage: 100–125V AC or 200–240V AC (wide-range power supply input voltage)
- Frequency: 50Hz to 60Hz, single phase
- Maximum current: At least 10A (low-voltage range) or 5A (high-voltage range)
- Operating temperature: 50° to 95° F (10° to 35° C)
- Storage temperature: –40° to 149° F (–40° to 65° C)
- Relative humidity: 5% to 95% noncondensing
- Maximum altitude: 10,000 feet

Size and weight

- Height: 20.1 inches (51.1 cm)
- Width: 8.1 inches (20.6 cm)
- Depth: 18.7 inches (47.5 cm)
- Weight (standard configurations): 44.5 to 48.8 pounds (20.2 to 22.1 kg)[10]

For More Information

For more information about the Power Mac G5, visit www.apple.com/powermac.

Internet access requires a compatible Internet service provider; fees may apply. Product contains electronic documentation. Backup copy of software is included. [1]Testing conducted by Apple in September 2005 using preproduction 2.5GHz Power Mac G5 Quad units; all other systems tested were shipping units. [2]1GB = 1 billion bytes and 1TB = 1 trillion bytes; actual formatted capacity less. [3]Wireless Internet access requires AirPort Extreme technology, a base station or other wireless access point, and Internet access (fees may apply). Achieving data rates up to 54 Mbps requires that all users have an 802.11g-enabled computer and connect to an 802.11g wireless access point. Some ISPs are not compatible with AirPort. Streaming music requires a compatible stereo system or powered speakers. Range may vary with site conditions. [4]Actual rates will vary. [5]Eight 20-inch or 23-inch Apple Cinema Displays can be connected to the Power Mac G5 using four NVIDIA GeForce 6600 graphics cards. [6]Stereo-in-a-window requires an NVIDIA Quadro FX 4500 graphics card, a CRT display, and stereo goggles (sold separately). [7]The NVIDIA GeForce FX 4500 graphics card occupies the 16-lane PCI Express slot and adjacent PCI Express slot. [8]S-video and composite video output are supported by the NVIDIA GeForce 6600 LE and 6600 cards. [9]The Apple Wireless Keyboard and Mouse require Bluetooth technology. [10]Weight varies by configuration and manufacturing process.

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